Appendix J.1
Preliminary Design Report

ST01 - Liffey Valley

Pedestrian Bridge

CBC006-ST01 N4 Pedestrian Bridge Preliminary Design Report

Lucan to City Centre Core Bus Corridor
BCIDA-ACM-STR_ZZ-0006_XX_00-RP-CB-0002

Client – National Transport Authority
Stage – Stage 2

Project Reference: BusConnects Package A
Project Number: 60599123
BCIDA–ACM-STR_ZZ–0006_XX_00–RP–CB–0002

Date (20th August 2021)

Preliminary Design Report – Consultation

STA-1b

Categories 1, 2 & 3

Scheme

Name and Location BusConnects – CBC 06 Lucan to City Centre

Structures(s)

Name and nature of the Structure(s) CBC006-ST01 N4 Pedestrian Bridge

Preliminary Design Report

Reference BCIDA–ACM-STR_ZZ–0006_XX_00–RP–CB–0002

Revision L04

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Date: - 20-08-2021

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1. Introduction

1.1 Brief

The BusConnects Dublin – Core Bus Corridor (CBC) Infrastructure Works (herein after called the CBC Infrastructure Works) involves the development of continuous bus priority infrastructure and improved pedestrian and cycling facilities on sixteen radial core corridors in the Greater Dublin Area.

The National Transport Authority (NTA) have appointed AECOM in a joint venture with Mott MacDonald to undertake the design of the infrastructure works for Package A of the BusConnects Programme. Package A includes the following four CBC routes:

Clongriffin to City Centre CBC;

Lucan to City Centre CBC;

Clondalkin to Drimnagh CBC; and

Tallaght to City Centre CBC.

Each route contains several bridge structures with various structural forms. As part of the scope AECOM have agreed to take all structures which affect the Transport Infrastructure Ireland (TII) Road Network through the *Technical Acceptance of Road Structures on Motorways and Other National Roads* procedure as outlined in DN-STR-03001.

This Preliminary Design Report (PDR) will focus on CBC006-ST01, a new Pedestrian Bridge over the N4 near Liffey Valley Shopping Centre. The new bridge will be located within the TII road network and the Lucan to City Centre corridor of the BusConnects Programme. The PDR is a deliverable at Phase 4 of the Technical Acceptance process.

1.2 Background information

Within BusConnects, there are 16 radial CBCs and plans for a number of orbital bus routes that will service the wider Dublin area to be developed. The new bridge will be constructed as part of the Lucan to City Centre CBC. This CBC commences at Ballyowen Road Bridge at Junction 3 on the N4. The CBC progresses east following the N4 to Junction 7 on the M50 where it continues via the R148 along the Palmerstown Bypass, Chapelizod Bypass, Con Colbart Road and St. John's Road West until tying in with the bus infrastructure along the Quays at the Frank Sherwin bridge beside Heuston Station.

As part of the Lucan to City Centre CBC, the existing bus stops which service Liffey Valley Shopping Centre (LVSC) are being relocated west and lengthened to accommodate increased bus traffic. This relocation also improves the weaving distances to and from the adjacent major junction between the N4, M50 and R148. The new bridge has been positioned to provide a more direct link between the relocated bus stops either side of the N4 and LVSC. The bridge will be solely for the use of pedestrians with no cycle facilities provided. The bridge is expected to become the main gateway for pedestrians and bus users entering and exiting LVSC.

As part of Liffey Valley to City Centre CBC, a new bus interchange will be constructed within the existing LVSC carpark and serviced by a number of orbital bus routes. The bridge will also provide a vital passageway for commuters between the new bus interchange, serving a number of future orbital bus routes, located within the existing LVSC carpark and the Lucan to City Centre CBC.

1.3 Previous studies and their recommendations

The following table is a list of documents as part of previous studies for the development of the proposed bridge:

Table 1.1 Previous Studies

Date	Document Reference	Report Title	Author
October 2020	BCIDA-ACM-STR_ZZ-0000_XX_00-RP-CB-0001	Structures File Note	AECOM
October 2020	BCIDA-ACM-STR_ZZ-0000_XX_00-RP-CB-0002	Outline Structures Report	AECOM
February 2021	BCIDA-ACM-STR_ZZ-0006_XX_00-RP-CB-0001	CBC006-ST01 N4 Pedestrian Bridge Structures Options Report	AECOM
2020	RPT-16_080-004 (DRAFT)	Lucan to City Centre Core Bus Corridor Options Study – Feasibility Report	AECOM
2020	BCIDA-ACM-PMG_PD-0006_XX_00-RP-ZZ-0001 (DRAFT)	CBC06 Preferred Route Options Report	AECOM

The Structures Options Report (SOR) assessed three different bridge options for the N4 Pedestrian Bridge. The report assessed each option based on a Multi Criteria Assessment (MCA) and recommended that Option 1 Steel Through Truss should be taken forward to preliminary design as the emerging preferred bridge option. A signed STA-1a form has been received from TII confirming consultation for the SOR stage.

2. Site & Function

2.1 Site location

The N4 Pedestrian Bridge will be constructed over the N4, situated to the west of the existing Liffey Valley Footbridge, SD-N04-010.00 near LVSC, Co. Dublin. The co-ordinates of the bridge are 706961.721 (E), 735171.243 (N) (ITM).

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Figure 2.1 Location Plan

2.2 Function of the structure and obstacles crossed

The bridge will span eight lanes of the N4 national primary road. The bridge will service the proposed bus stops on the N4, LVSC and the new bus interchange within LVSC carpark.

2.3 Choice of location

The bridge location has been chosen to provide the optimal pedestrian link between the relocated bus stops on the N4, LVSC and the new bus interchange within LVSC carpark.

2.4 Site description and topography

The surrounding area is a busy urban environment with several existing structures, infrastructure and street furniture acting as constraints to the design, location and construction of the bridge. The topography of the site is relatively flat across the site with the exception of a steep embankment on the southern side between the N4 westbound traffic lanes and Fonthill Road.

The N4 is a busy primary traffic route with high traffic volumes which poses significant construction constraints. At the crossing location, the bridge will span eight lanes of the N4 which includes three traffic lanes and a bus lane in the eastbound direction and three traffic lanes with a bus lane in the westbound direction.

To the east of the bridge the area is occupied by the existing Liffey Valley Footbridge and its associated access ramps and steps. The existing bridge currently operates as a shared pedestrian and cycle facility offering a vital link between the N4 bus stops, LVSC and Kings Hospital School to the north east and will remain operational during and after construction has completed for the N4 Pedestrian Bridge. The existing ramp on the south side of the N4 providing access between the westbound N4 bus stop and the existing Liffey Valley Footbridge and shopping centre will become obsolete once the N4 bus stops have been shifted west and construction is completed for the new N4

Pedestrian Bridge. As a result, this existing access ramp to the Liffey Valley Footbridge will be removed. No further works are proposed to the existing footbridge.

On the south western side of the bridge is an existing office building with associated carparking and boundary/retaining walls which are separated from the N4 by a steep earthwork's embankment. Further south is LVSC and the associated car parks. To the north side of the N4 there is an existing South Dublin County Council (SDCC) fenced compound with a number of small buildings and a heavily vegetated embankment between the N4 and Old Lucan Road. Along Old Lucan Road there is a number of protected structures consisting of old houses, lodges, gates and a milestone. There is also a number of existing lighting columns, signage gantries and services which must be considered.

2.5 Vertical and horizontal alignment

The vertical alignment of the bridge will be detailed to ensure a minimum vertical clearance of 5.7m to the N4 carriageways. To meet this minimum requirement a longitudinal fall of 1.36% from northern support to the southern support will be incorporated. The alignment crossfall will be a standard 2.5% either side of the centre line to aid drainage of the bridge. The horizontal alignment of the bridge will be designed straight from Fonthill road over the N4 at a skew of 0º to the perpendicular.

2.6 Cross sectional dimensions on the alignments

The proposed cross-section of the bridge is provided below:

Table 2.1 N4 Pedestrian Bridge Cross-Section

Section	Width (m)
Truss Chord	0.30
Pedestrian Walkway	3.00
Truss Chord	0.30
Total	**3.60**

The N4 cross section at the bridge location is as follows:

Table 2.2 N4 Primary Road Cross-Section

Section	Width (m)
Eastbound Bus Lane	3.21
Raised Island	1.47
Eastbound Carriageway	11.75
Central Reserve	4.79
Westbound Carriageway	11.23
Westbound Bus Lane	3.92
Total	**36.37**

2.7 Existing underground and overground services

There are a large number of existing underground services along the verges of the N4 carriageway and along Fonthill Road at the bridge tie-in point. These services consist of stormwater and foul water drainage pipes, underground ESB low voltage, medium voltage & high voltage and EIR ducts.

Overground services in the area consist of a low voltage ESB line along Old Lucan Road as well as lighting columns lining the verges of the N4 carriageways and a large portal gantry over the N4 eastbound carriageway.

2.8 Geotechnical summary

2.8.1 Ground Investigation

Six boreholes (R6-CP03 to R6-CP08) were carried out as part of the ground investigation to inform the planning design. The locations are shown in the figure below.

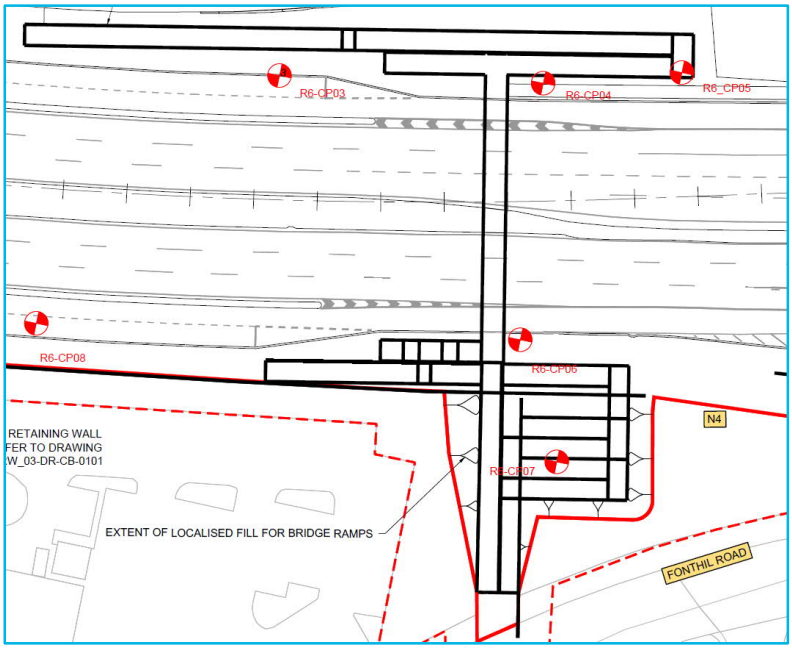


Figure 2.2 Borehole Locations

In general, the ground investigations utilised the following exploratory techniques:

- R6-CP03 and R6-CP08 comprised of cable percussion (CP) boring sunk using shell and auger techniques. This technique was used to investigate the superficial ground conditions, undertaking in-situ testing and taking undisturbed and disturbed samples for geotechnical/geochemical laboratory testing. Typically, CP boreholes were terminated on encountering refusal on very dense/stiff soils, boulders or weathered bedrock, or at a predefined depth based on the design and construction requirements for the proposed bridge/earthworks or upon encountering suspected services;
- In R6-CP07 follow on Rotary drilling with core recovery (RC) was typically used in soils to extend CP boreholes beyond obstructions (i.e. very dense/stiff soils or boulders), where more soil information was required than would be recovered by RO methods. The use of a geotechnical wireline triple tube core barrel S-size ("Geobor") allowed recovery of good quality (Class 1) samples. RC was typically used in rock to provide information on the rock (i.e. lithology, discontinuities, strength, etc.) and recover core samples suitable for laboratory testing;
- R6-CP04-07 comprised window sampling boreholes at locations, which were unsuitable to access by means of CP rigs; the window sampling rig was smaller and easier to mobilise to difficult locations. The window sampler was used to identify superficial ground conditions, taking disturbed samples for geotechnical/ geochemical testing and carrying out SPTs. Typically, the window sampling boreholes were terminated on very dense/stiff soils or on possible boulders or bedrock; and
- Groundwater monitoring standpipes, installed to identify groundwater levels, provide water samples for geochemical testing and monitor groundwater flow.

2.8.2 Ground Summary

The following sequence of ground conditions are expected to be present at the site in approximate stratigraphic order.

- Made Ground; overlying
- Thin Sand and Gravel layers; overlying

- Glacial Till: overlying
- Limestone Bedrock.

An interpreted geotechnical longitudinal section is shown and a summary of the available ground investigation data is recorded in the figure and table below respectively:

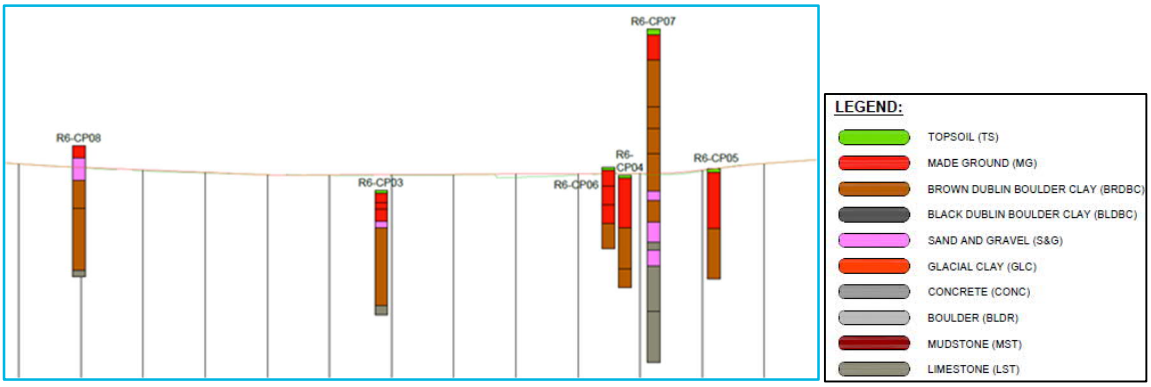


Figure 2.3 Geotechnical Longitudinal section

Table 2.3 Ground Summary

Stratum	Typical Stratum Description	Depth at Top of Stratum (m bgl)	Level at Top of Stratum (m AOD)	Thickness Range (m)	Occurrence
Topsoil	Topsoil	0	56.05 – 50.90	0.1 – 0.2	R6-CP03, R6-CP04, R6-CP05, R6-CP06, R6-CP07
Made Ground	Typically soft with firm to stiff brown sandy gravelly CLAY (likely reworked Glacial Till) and loose grey angular to sub angular fine to coarse Gravel (Highway Fill)	0-0.20	55.85 – 50.77	0.4 – 1.8	R6-CP03, R6-CP04, R6-CP05, R6-CP06, R6-CP07, RP-CP08
SAND and GRAVEL	Loose brown gravelly silty fine to coarse SAND to silty sandy fine to coarse GRAVEL	0.40-7.10	51.90 – 48.95	0.2 – 0.7	R6-CP03, R6-CP07, R6-CP08
Glacial Till	Typically stiff to very stiff sandy gravelly CLAY/SILT, with soft deposits noted	1.0-5.50	55.05 – 49.65	2.5 – 4.2	R6-CP04, R6-CP05, R6-CP06, R6-CP07, R6-CP08 Soft deposits noted in R6-CP04, R6-CP07, R6-CP08

Bedrock/ possible bedrock	Medium strong thinly bedded dark grey Limestone (proven in R6-CP07) Possible bedrock described as GRAVEL/COBBLES of limestone encountered in R6-CP03 and R6-CP08	6.85 (proven in R6-CP08) 3.7 to 4 (possible bedrock in R6-CP03 and R6-CP08)	49.20 (proven) 47.17 to 48.3 (not proven)	Not proven -3.10 m of core in R6-CP07	R6-CP07 (proven), R6-CP03, R6-CP08 (possible bedrock)

2.9 Hydrology and hydraulic summary

The River Liffey forms the main hydraulic feature in the surrounding area. The River Liffey is located approximately 500m to the north of the bridge location with no other major waterways or distributary stream in the immediate surrounding area.

A review of the OPW flood mapping (www.floodinfo.ie) shows that there are no historical events pertaining to flooding at the bridge location as of 2nd February 2021. A review of CFRAMS model output for fluvial flooding for the present day shows that the bridge is located outside of the River Liffey's flood zone for the 0.1% Annual Exceedance Probability (AEP).

2.10 Archaeological summary

No sites of major archaeological importance were identified at the proposed bridge location during the EIA stage of the project.

2.11 Environmental summary

The EIAR prepared as part of the preliminary design did not identify any particular major environmental impacts associated with the construction of the bridge. The main findings of the EIAR relating to the bridge are as follows:

Removal of trees, which make a positive contribution to the setting of the historic buildings and structures on Old Lucan Road, will be required for the construction of the new bridge. The works do not directly impact the historic buildings and structures on Old Lucan Road but do affect views to and from the properties. Appropriate planting and screening of the bridge should be provided for as part of the overall scheme. In addition, reinstatement of the landscape at Liffey Valley Shopping Centre should be included to help integrate the proposed scheme into the surrounding environment. There is the potential for construction activities, to result in adverse noise impacts at properties on Old Lucan Road this will need to be mitigated as part of the design.

3. Structure & Aesthetics

3.1 General description of recommended structure or family of structures and design working life

The bridge will be a two-span structure formed of a main span warren truss (42.14m) spanning the N4 carriageways with a back-span ladder beam (9.78m) spanning the approach ramps, N4 retaining wall and steep embankment. The bridge will be formed in painted structural steel, supported on braced steel support piers to the north and south of the N4. A high-level bank seat abutment will also be provided within the embankment. The bridge will be fully integral with bolted connections between the superstructures and supports. Expansion and contraction of the bridge will be accounted for through flexure of the steel piers. The north and south piers will consist of two steel columns braced together to provide lateral stiffness and will be supported on reinforced concrete end-bearing pile foundations. The longitudinal top and bottom chords, vertical, diagonal and horizontal bracing will be formed from steel hollow sections. The truss will be designed with full-through construction where the structure is built up around the deck. A steel mesh will be fitted to the vertical and horizontal bracing to create a fully enclosed structure. Painted steel approach ramps and steps will also be provided to tie in at the bridge support piers. These elements will be formed in steel hollow sections to match the bridge span.

The design working life of the bridge will be a minimum of 120 years as defined in the TII publication, DN-STR-03012 - Design for Durability. Maintainable elements and components listed below are subject to greater wear and will require replacement within the design life. Careful design and detailing combined with thorough routine inspections, quality control and supervision on site will help achieve the minimum expected design life listed in the below table:

Table 3.1 Minimum Design Life for Structural Elements

Component	Years
Parapets	50
Drainage Systems	50
Deck Waterproofing	50
Steelwork Paint Systems	20

3.2 Aesthetic considerations

The bridge design has been developed to take account of the basic principles of aesthetics which respects the surrounding landscape, minimises the environmental intrusion and protects existing vegetation where possible. Positioning and arrangement of the bridge and ramps will respect the existing natural visual screen adjacent the N4 eastbound carriageway and link the areas zoned, according to SDCC, “to protect and enhance natural character” to the north of the N4 and “provide for future development of a Major Retail Centre” to the south of the N4. The bridge will create a physical connection between these two zones, respecting and adhering to the objectives set out by the county council.

The form of the N4 Pedestrian Bridge will match the existing Liffey Valley bridge, with similar proportions, structural depths, parapets and finishes creating a consistent design language in the area and giving the perception of a family of structures. The bridge will be made as simple as possible having a clear expression of function from the positioning of the bridge and articulation of the ramps between the N4 bus stops and LVSC. The bridge will be constructed in painted steel, with the choice of paint colour to be determined at detailed design. The choice of colour will be in accordance with DN-STR-03007 and BS4800.

The structural depth of the bottom chord of the truss and the longitudinal members of the ladder beam shall match to ensure a constant structural depth across the entire elevation. The bridge aesthetics will be considered in depth during detailed design with the CIRIA C543 Bridge Detailing Guide used to determine a number of aesthetic requirements thus ensuring consistency across the bridge.

3.3 Proposals for the recommended structure or family of structures

3.3.1 Proposed Category

The bridge will be a Category 2 structure as the main span is greater than 10m and less than 50m in accordance with TII publication DN-STR-03001 Technical Acceptance of Road Structures on Motorways and Other National Roads.

3.3.2 Span Arrangements

The bridge will be a two-span structure composed of a main span warren truss of approximately 42.14m over the N4 carriageways with an internal clear width of 3m. A ladder beam structure will form a back span of 9.78m extending from the southern bridge support pier over the approach ramps, proposed N4 retaining wall and the existing steep embankment to the tie-in point at Fonthill Road.

3.3.3 Minimum headroom provided

A minimum vertical clearance of 5.7m will be provided to the N4 carriageways below the bridge in accordance with TII publication DN-GEO-03036, Cross-Sections and Headroom.

The main span warren truss will be fully enclosed with a minimum internal headroom of 2.3m above the finished surface level in accordance with TII publication DN-STR-03005, Design Criteria for Footbridges. Where the southern access ramp extends below the ladder beam span a clearance of 4.5m has been provided between the surfacing of the access ramp and soffit of the ladder beam structure.

3.3.4 Approaches including run-on arrangements

The bridge will be required to provide three tie-in points to the existing and proposed infrastructure. Two of the tie in points will be at the relocated bus stops on the eastbound and westbound carriageways of the N4. The third tie in point will be at Fonthill Road offering access to and from LVSC and the new bus interchange as part of the CBC07 Liffey Valley to City Centre.

The northern access ramp servicing the eastbound bus stop will have an overall length of 134m. The ramps initial 52m length commencing at finished bus stop level will be formed using precast concrete U-sections retaining a structural earthworks fill. The structural earthworks ramp will then transition into a steel ladder beam solution for the remaining 82m, supported on steel supports at 15m intervals, to the bridge deck level. These supports will be positioned on top of 1.5m high robust concrete plinths supported on spread foundations.

The southern access ramp servicing the westbound bus stop will be significantly shorter structure than the northern ramp and will also be formed of a 59.2m ladder beam structure. The structural form of the ladder beam ramp superstructure and the supports will match the northern access ramp. Due to the site topography the ladder beam ramp will terminate at its intersection with the N4 Retaining Wall. At this point the ramp will continue as a graded earthworks solution to its end point at Fonthill Road.

All approach ramps will be designed in accordance with DN-STR-03005 and DMURS and be provided with a 1-in-20 gradient from finished deck level to finished bus stop level with 2m landings provided at equal intervals along the length of the ramps.

3.3.5 Foundation type

Reinforced concrete end-bearing piled foundations will be provided to the bridge piers. The high-level bank seat abutment will have a pad foundation supported on structural fill. The length of the piles will be confirmed during the detailed design stage and are dependent on the depth to bedrock at the north and south support locations.

3.3.6 Substructure

The superstructure will be supported on a pair of braced vertical steel columns to the north and south of the N4 respectively. In accordance with Section 2.3 of DN-STR-03013, Use of IS EN 1991-1-7 for the Design of the

Accidental Actions, the supports of the N4 Pedestrian Bridge will be positioned on top of 1.5m high robust concrete plinths. These plinths shall also be provided to the ramps supports to resist accidental actions.

The steel ladder beam structure spanning from the south bridge support towards Fonthill Road will be supported on a high level reinforced concrete bank seat abutment positioned on the steep embankment between the N4 and Fonthill Road.

3.3.7 Superstructure

The superstructure will consist of a main-span full-through warren-truss structure which will be fully integral with the northern and southern piers. The full-through truss arrangement has the advantage of reducing the construction depth and ease at which the clearance envelope over the N4. Structural steel hollow sections will be used as the main top and bottom longitudinal chord members. Diagonal bracing between the top and bottom chords will stiffen the superstructure against deflection. Horizontal bracing will be provided between the top chords adding lateral stability to the structure. A steel mesh will be attached to the vertical and horizontal bracing creating a fully enclosed structure. An internal headroom of 2.3m will be provided within the enclosure.

The back span will be formed of a steel ladder beam structure formed of steel hollow sections. The ladder beam will be fully integral with the southern pier and a high-level bank seat abutment. The main longitudinal beams will match the depth of the main truss longitudinal beams to give a continuous line when the bridge is viewed in elevation.

3.3.8 Articulation arrangements, joints and bearings

The bridge will be designed to be fully integral at the superstructure and supports. The result is that no bearings or expansion joints will be required with the flexural capabilities of the steel columns used to allow for thermal expansions or contractions.

3.3.9 Vehicle Restraint System

No vehicle restraint system is required to the bridge superstructure.

The southern bridge pier will be set-back a minimum of 1.5m from the carriageway edge but will remain located within the clear zone for the N4 westbound carriageways. A concrete vehicle restraint system will be provided between the westbound carriageway and bridge supports to prevent accidental impact on the bridge supports. The safety barrier will have a minimum set-back from the carriageway edge of 600mm and W1 working width class in accordance with DN-REQ-03034. The safety barrier will extend a minimum of 30m on approach and departure from the supports in accordance with TII publication DN-REQ-03034, The Design of Road Restraint Systems (Vehicle and Pedestrian) for Roads and Bridges.

The northern bridge pier will be located 4m from the edge of carriageway. No safety barrier will be provided on approach to this pier as the design speed for the proposed bus lane will be 50 km/h with a clear zone requirement of 3.0m in accordance with DN-GEO-03036 Cross Sections and Headroom. At the bridge location the proposed bus lane will also be segregated from the main N4 traffic lanes (with 60 km/h design speed) by a raised concrete island limiting the risk from of accidental impact with the pier.

3.3.10 Drainage

The bridge design shall incorporate a longitudinal fall of approximately 1.36% over the bridge deck and a standard cross-fall of 2.5% over the bridge deck to ensure water drains from the surface avoiding the need for longitudinal drainage systems along the bridge deck, in addition this also limits the risk of standing water and ice on the bridge deck. Drainage systems will be provided at either end of the bridge to prevent the free fall of water from the bridge piers.

3.3.11 Durability

The bridge will be designed in accordance with the TII publication DN-STR-03012 - Design for Durability with a minimum design life of 120 years. The design life for replaceable parts such as waterproofing systems, surfacing and mesh will be 50 years in accordance with DN-STR-03012. The design working life of the bridge will be working life category 5 while replaceable parts will be working life category 2 in accordance with GE-POL-01008.

All exposed structural steelwork will have a protective paint system applied such that no maintenance shall be required up to 12 years and no major maintenance before 20 years. The steelwork will be designed and detailed to discourage the accumulation of water, dirt and debris and minimise the risk of rusting or deterioration. Intermittent welds will be avoided, with simple connections utilised as the preferred.

All buried concrete surfaces will be treated with two coats of epoxy resin waterproofing in accordance with DN-STR-03012 – Design for Durability and CC-SPW-02000 Specification for Road Works Series 2000 – Waterproofing for Concrete Structures.

All exposed concrete surfaces will receive a hydrophobic pore lining impregnation in accordance with DN-STR-03012 – Design for Durability and CC-SPW-02000 Specification for Road Works Series 2000 – Waterproofing for Concrete Structures.

3.3.12 Sustainability

Structural steel members will be prefabricated in a factory with high precision and efficiency. This reduces the material waste and waste disposal requirements thus reducing the environmental impacts and harmful emissions created in production.

A large percentage of structural steel used within the bridge construction will contain recycled or reused steel which has been reclaimed or salvaged from other projects. This recycled steel is in huge demand due to its ability to be reused in rolled steel sections.

The use of cement replacement products, such as Ground Granulated Blast Slag (GGBS) will be maximised in the foundation design, reducing the environmental impacts of concrete production. The replacement levels will be in accordance with the levels specified within IS EN 206:2013.

3.3.13 Inspection and maintenance

Maintenance and inspection of the N4 Pedestrian Bridge will be required throughout its service life. The inspections will be carried out in line with the TII EIRSPAN Bridge Management System. The EIRSPAN system was introduced in 2001 to provide an integrated management system for the bridges in Ireland. The system coordinates activities such as inspection, repairs and maintenance work to ensure optimal management of the bridge stock. As a minimum the following inspection regime should be implemented:

- Routine Inspection – every year;
- Principal Inspection - every six years.

The full-through structural form enables inspection and minor maintenance of the top of deck, top chord, vertical and horizontal bracing and mesh to be carried out from the deck level. Inspection and maintenance of the bridge soffit will require access from the N4 carriageway and temporary lane closures. The soffit of the bridge can be designed to incorporate details allowing rope inspections which eliminates the need for MEWP access to the N4. Lane closures should be programmed to coincide with inspection of the existing Liffey Valley Footbridge to minimise disruption to traffic.

4. Safety

4.1 Traffic management during construction including land for temporary diversions

The bridge is to be constructed over the N4 carriageway, a highly trafficked primary road, and to the west of a major junction between the N4, M50 and R148. The construction sequence will avoid construction within/over the carriageway where possible and reduce the need for traffic management measures on the N4. The bridge has been detailed with a main clear span over the N4 to avoid works within the N4 central reserve and associated traffic management.

The bridge will be fabricated in an offsite location and assembled within the temporary land take boundary within the LVSC. Erection of the superstructure will be carried out by a crane positioned on the N4 carriageway/hard shoulders. During the bridge erection all carriageways of the N4 will be closed to eastbound and westbound directions with significant traffic management required to divert traffic. It is expected that during the closures traffic will be diverted via N4 Junction 2, via LVSC, Coldcut Road, Kennelsfort Road and on to the Chapelizod Bypass. It is expected that closure of the N4 carriageways will be limited to a single closure during night-time or weekend works, limiting the effects on traffic flow.

During construction stage, a vertical clearance of 5.7m to the N4 carriageways will be maintained at all times.

4.2 Safety during construction

As part of the design development, a Designer's Risk Assessment (DRA) has been prepared in accordance with the Safety, Health and Welfare at Work (Construction) Regulations 2013 and the amendments of 2019 and 2020. The DRA shall be viewed as a working document to be developed further as the design develops. The DRA includes all risks identified and the resulting mitigation measures or alterations incorporated within the design, where no mitigation is possible the DRA will be used to communicate the risks to the Contractor and site personnel.

Where possible, the hierarchy of risk control will be implemented within the design and construction, with the Designer and Contractor aiming to control all risks through elimination. Where this is not possible, reduction, isolation or mitigation controls will be incorporated to ensure safety during construction.

The bridge will be detailed with a main span over the N4 eliminating construction requirements within the central median of live carriageways and minimising disruption to traffic. A site compound will be established with the LVSC site boundary and away from the N4 carriageway allowing for storage and assembly of the prefabricated structural steel units and minimising construction requirements over the live carriageways. Hoarding, fencing and secure compound entrance locations will need to be established to prevent access from the public potentially leading to injury and mitigate the risk of vandalism and theft of construction equipment.

The location of the new N4 Pedestrian Bridge is approximately 200m west of the existing Liffey Valley Footbridge. The bridge currently offers a safe access route for pedestrians and cyclists over the N4 between LVSC, N4 bus routes and King's Hospital School. This existing bridge should be maintained fully operational for pedestrians and cyclists until the new bridge is complete. Site compounds and site access routes should account for pedestrian and cyclist movement and safety around the existing footbridge. The existing access ramps and steps servicing the N4 bus stops from the existing footbridge should be kept clear and operational during construction with the minimum headroom for pedestrian and cyclist access always maintained.

4.3 Safety in use

Safety of the end user will be considered as part of the Designer's Risk Assessment. An Engineer Routine inspection will be carried out at least once a year or after any significant event in line with the recommendations contained within the EIRSPAN Bridge Management System, as defined by TII. The routine inspection will take account of any defects and establish whether the bridge requires a Principal Inspection to be carried out or if routine maintenance consisting of simple remedial works is sufficient to maintain the safety of the day to day pedestrian traffic on the bridge. A Principal Inspection can only be carried out by an approved Principal Inspection Team Leader according to the TII Bridge Management Section. The Principal Inspection shall record all findings from the bridge on the EIRSPAN database for future reference.

Pedestrian bridges in the past have been susceptible to dynamic excitation, due to the frequency of pedestrian movements and wind loading. Depending on the conditions, if the frequency of the loading approaches the natural frequency of the bridge it can result in excessive vibrations causing discomfort to the user. A dynamic analysis will be carried out as part of detailed design to determine the natural frequency and response of the bridge to movement. This analysis will allow the designers to make adjustments to the bridge design such as increasing the dead load moving the natural frequency of the bridge away from the expected range of frequencies from the live loading and improving the comfort of the user. The bridge will also be designed for potential crowd loading in accordance with IS EN 1991-2.

The bridge incorporates a longitudinal fall and cross fall across the deck to mitigate the slip hazard due standing water and ice on the deck surface. The access ramps will have a constant gradient of 1-in-20 in line with DMURS recommendations. The main bridge span will be fully enclosed structure reducing the risk of anti-social behaviour, objects being dropped onto vehicles passing beneath the bridge and users falling or jumping from the bridge deck.

Where the bridge piers are situated within the carriageway clear zone, vehicle restraint systems will be provided as defined by TII Publication DN-GEO-03036 Cross Sections and Headroom. The vehicle restraint systems will provide sufficient approach and departure lengths between the bridge supports and carriageway to protect against collision from an errant vehicle and account for the working width of the restraint system and vehicle intrusion width.

Construction of the bridge has potential to restrict visibility to an existing portal frame gantry 150m to the east of the bridge. The gantry straddles the eastbound N4 carriageway 100m on approach to the M50 Junction 7 and provides advanced directional signage to the junction. The gantry is the final gantry on approach to the junction with two further gantries located to the west of the bridge providing 1km and 500m advance directional signage. Discussions on potential visibility issues for this gantry are currently ongoing. If required, the existing gantry may be relocated to ensure safety of the N4 users.

4.4 Lighting

Where required public lighting will be installed along the length of the bridge to improve visibility and reduce the risk of anti-social behaviour. The detailed lighting design will ensure that the lighting is vandal proof and easily maintained.

5. Cost

5.1 Budget Estimate in current year

The construction costs provided below have been based on quantities calculated from the preliminary bridge design and 3D model. Elements associated with bridge and ramps such as earthworks, piling, concrete, reinforcement, structural steelwork and waterproofing have been included. Rates have been based on AECOM's internal cost database or based on Spon's Civil Engineering and Highway Works Price Book 2021 as required. It should be noted that costs are indicative only and may vary depending on the detailed design and the Contractor's methodology.

During the preliminary design stage, Thompsons of Carlow Ltd. have been engaged to provide current Structural Steelwork rates (2021). The steel tonnage quantities were based off the preliminary design drawings provided in Appendix B. The rates provided include supply, fabrication, painting, installation and all associated quality assurance for all structural steel elements including bridge parapets.

Allowances have been made for preliminaries, consultancy fees and contingency. A budget of 25% of the construction cost has been provided for preliminaries to cover traffic management, PSCS, temporary accommodation etc. The contingency is 25% of the construction cost and will cover minor elements such as drainage, fencing, landscaping works and any unforeseen unknowns. Finally, an allowance of 10% of the construction cost has been provided for professional fees to deliver the bridge from detailed design to handover. These fees will include detailed design, CAT II checks, construction supervision and handover.

The rates used to calculate the amounts presented in Table 5.1 are all exclusive of VAT. No allowance has been made for land acquisition within the costs provided below. The cost of land acquisition will be covered under the construction costs for the entire BusConnects CBC06 Lucan to City Centre route.

Table 5.1 Budget Estimate in the current year

Series	Amount (€)
CC-SPW-00600 - Earthworks	64,550.41
CC-SPW-01600 - Piling and Embedded Retaining Walls	130,495.26
CC-SPW-01700 - Structural Concrete	239,722.51
CC-SPW-01800 - Structural Steelwork	1,266,686.88
CC-SPW-02000 - Waterproofing of Structures	130,680.00
Construction Cost	**1,832,135.06**
Preliminaries (25% of Construction Cost)	458,033.77
Contingency (25% of Construction Cost)	458,033.77
Professional Fees (10% of Construction Cost)	183,213.51
Total Cost	**2,931,416.10**

6. Design Assessment Criteria

6.1 Actions

6.1.1 Permanent Actions

Permanent actions and material densities will be applied in accordance with IS EN 1991-1-1 and the Irish National Annex. Material/partial factors will be as detailed in IS EN 1990 and the Irish National Annex. The accepted densities for principal construction materials are as follows:

Table 6.1 Material Densities for Design

Material	Density
Reinforced Concrete	25 kN/m^3
Structural Steelwork	78.5 kN/m^3
6N/6P backfill to structures	21 kN/m^3

6.1.2 Snow, Wind and Thermal Actions

Snow loads are not deemed a critical load case and will not be considered in accordance with the National Annex to IS EN 1991-1-3.

Wind loading will be considered in accordance with IS EN 1991-1-4 and the Irish National Annex. Wind loads will be taken to act simultaneously with other loads in accordance with the NA to IS EN 1990. Wind loads will not be considered in combination with thermal loading in accordance with clause A2.2.2 (6) of the NA to IS EN 1990.

Thermal loading will be considered in accordance with IS EN 1991-1-5 and the Irish National Annex. The combination of thermal and wind loading will not be considered for the bridge in accordance with the National Annex to IS EN 1990.

6.1.3 Actions relating to normal traffic

Not applicable.

6.1.4 Actions relating to abnormal traffic

Not applicable.

6.1.5 Footway or footbridge live loading

Actions on the bridge will be considered in accordance with IS EN 1991-2 and the Irish National Annex. The bridge will be designed for a uniformly distributed load pedestrian loading of 5kN/m^2. In addition, the bridge will also be designed for a concentrated load of 20kN acting on a square surface area 0.2m by 0.2m.

No service vehicle loading will be considered as part of the design as service vehicles will be excluded from crossing the bridge through the introduction of suitable bollards on approach to the bridge.

6.1.6 Provision for exceptional abnormal loads

Not applicable

6.1.7 Accidental actions

The bridge will be designed to provide a minimum of 5.7m clearance above the N4 carriageways avoiding the risk of accidental impact with the superstructure.

The risk of accidental impacts will be limited by the bridge and ramp substructures being set-back sufficiently outside of the clear zone of the carriageways or else protected by a suitable vehicle restraint system. Despite these precautions, all supports will be designed considering impact loads in accordance with Section 2 of DN-STR-03013

and Table NA.1 of the Irish National Annex to IS EN 1991-1-7. Robust concrete plinths 1.5m high have been included within the design of both the bridge and ramps supports to resist this impact loading.

6.1.8 Actions during construction

Actions arising during construction will be considered in accordance with IS EN 1991-1-6 and the Irish National Annex.

6.1.9 Any special loading not covered above

Not applicable.

6.2 Authorities consulted and any special conditions required

The following authorities have been consulted as part of the development of the scheme:

- South Dublin County Council
- Transport Infrastructure Ireland
- National Transport Authority
- Liffey Valley Shopping Centre

6.3 Proposed departures from standards

No departures from standards are envisaged for the design and construction of the bridge.

6.4 Proposed methods of dealing with aspects not covered by Standards

Not applicable.

7. Ground Conditions

7.1 Geotechnical Classification

Considering the guidance in IS EN 1997-1, it is considered that Geotechnical Category 2 is currently the most appropriate for the proposed bridge.

Geotechnical Category 2 is for conventional types of structure and foundations with no exceptional risk or difficult loading conditions. This includes spread footing, raft foundations, piled foundations, walls or other structures retaining or supporting water, excavations, bridge piers and abutments, embankments and earthworks, ground anchors and other systems and tunnels in hard, non-fractured rock and not subjected to special water tightness or other requirements.

7.2 Description of the ground conditions and compatibility with proposed foundation design

7.2.1 Northern Supports

Due to the presence of soft glacial soils in R6-CP03 and R6-CP04, it is likely that the ground will need some form of improvement to allow shallow pad foundations. The soft soils would be required to be dewatered, excavated and replaced with 6N or the foundations founded at bedrock level. To avoid large excavations and excessive temporary works adjacent to the N4, a piled foundation solution with the piles generating the majority of their geotechnical capacity from end bearing in the underlying bedrock has been progressed for the preliminary design.

7.2.2 Southern Supports

Preliminary geotechnical analysis of the foundation options found that provided the foundations are adequately sized during the detailed design phase, shallow pad foundations founded on the stiff to very stiff Glacial Till could achieve Serviceability Limit State settlements of less than 25 mm.

Despite this, a piled solution has been preferred in the preliminary design to avoid excessive temporary works in terms of the excavation intrusion into the N4 carriageways and associated traffic management. In addition, a piled solution will also limit the risk of the differential settlement between the north and south bridge supports.

8. Drawings and Documents

8.1 List of all documents accompanying the submission

The following table lists the drawings accompanying this submission. The drawings are contained within Appendix B:

Table 8.1 N4 Pedestrian Bridge Drawing List

Drawing Number	Revision	Drawing Title
BCIDA-ACM-STR_GA-0006_BR_03-DR-CB-0101	L04	ST01 – N4 Pedestrian Bridge Plan
BCIDA-ACM-STR_GA-0006_BR_03-DR-CB-0102	L04	ST01 – N4 Pedestrian Bridge Details Sheet 1
BCIDA-ACM-STR_GA-0006_BR_03-DR-CB-0103	L01	ST01 – N4 Pedestrian Bridge Details Sheet 2

Appendix A Photographs and Photomontages

8.2 3D Preliminary Design Model

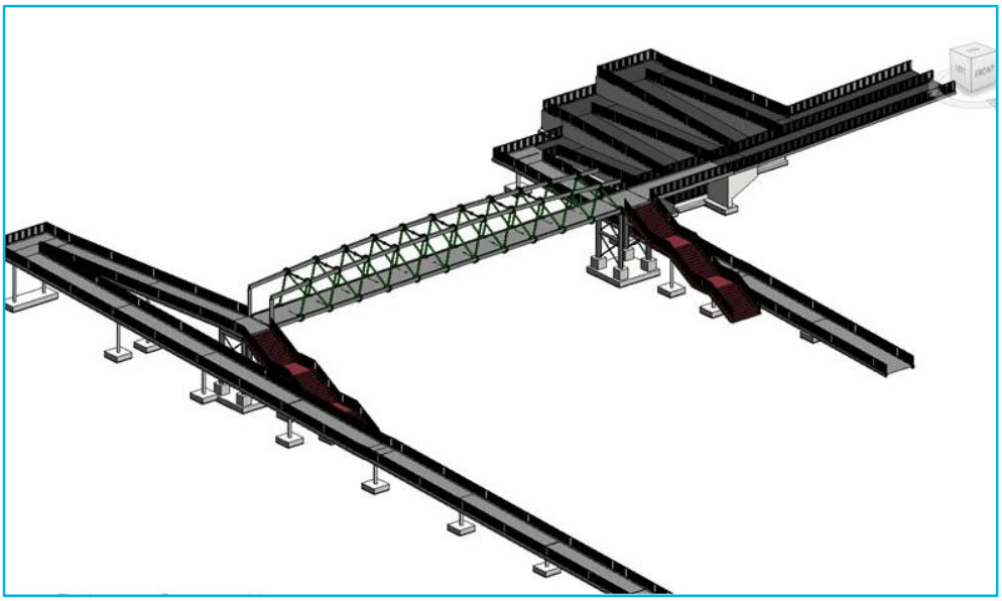


Figure A.1 N4 Pedestrian Bridge 3D Interactive Model looking south east

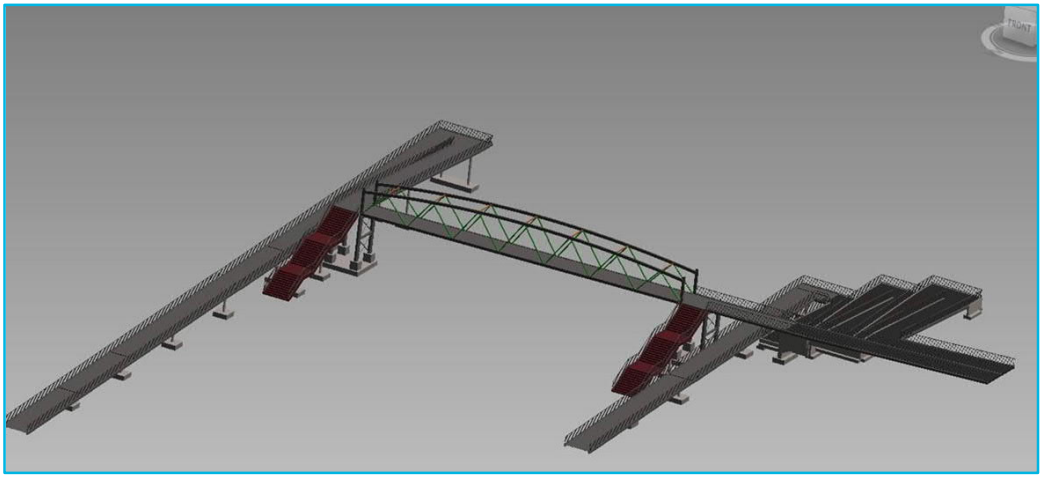


Figure A.2 N4 Pedestrian Bridge 3D Interactive Model looking north east

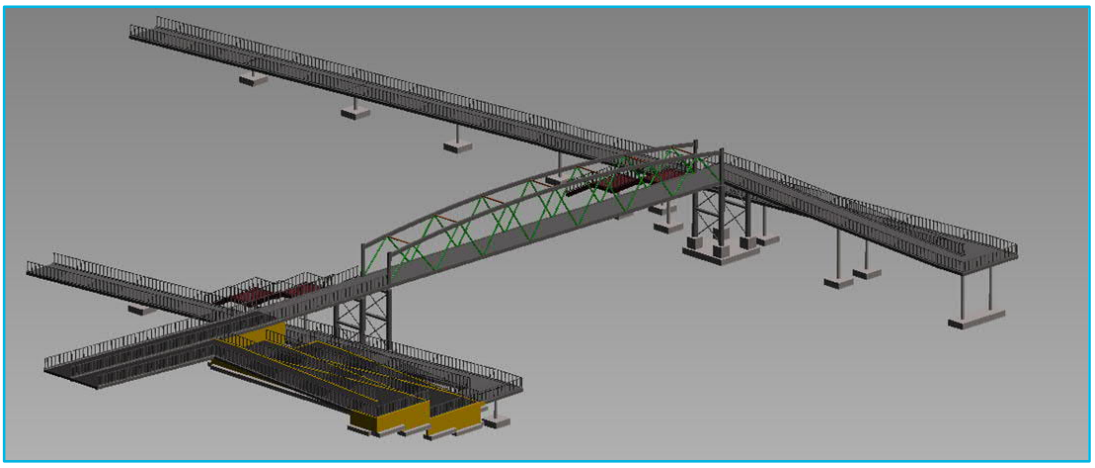


Figure A.3 N4 Pedestrian Bridge 3D Interactive Model looking north west

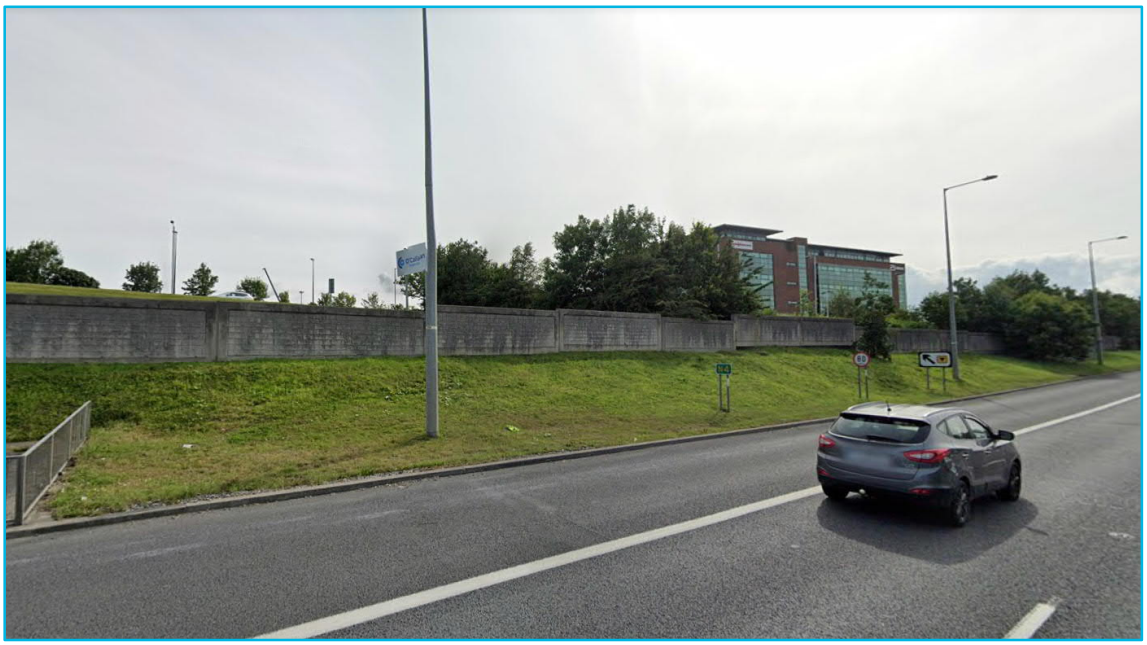
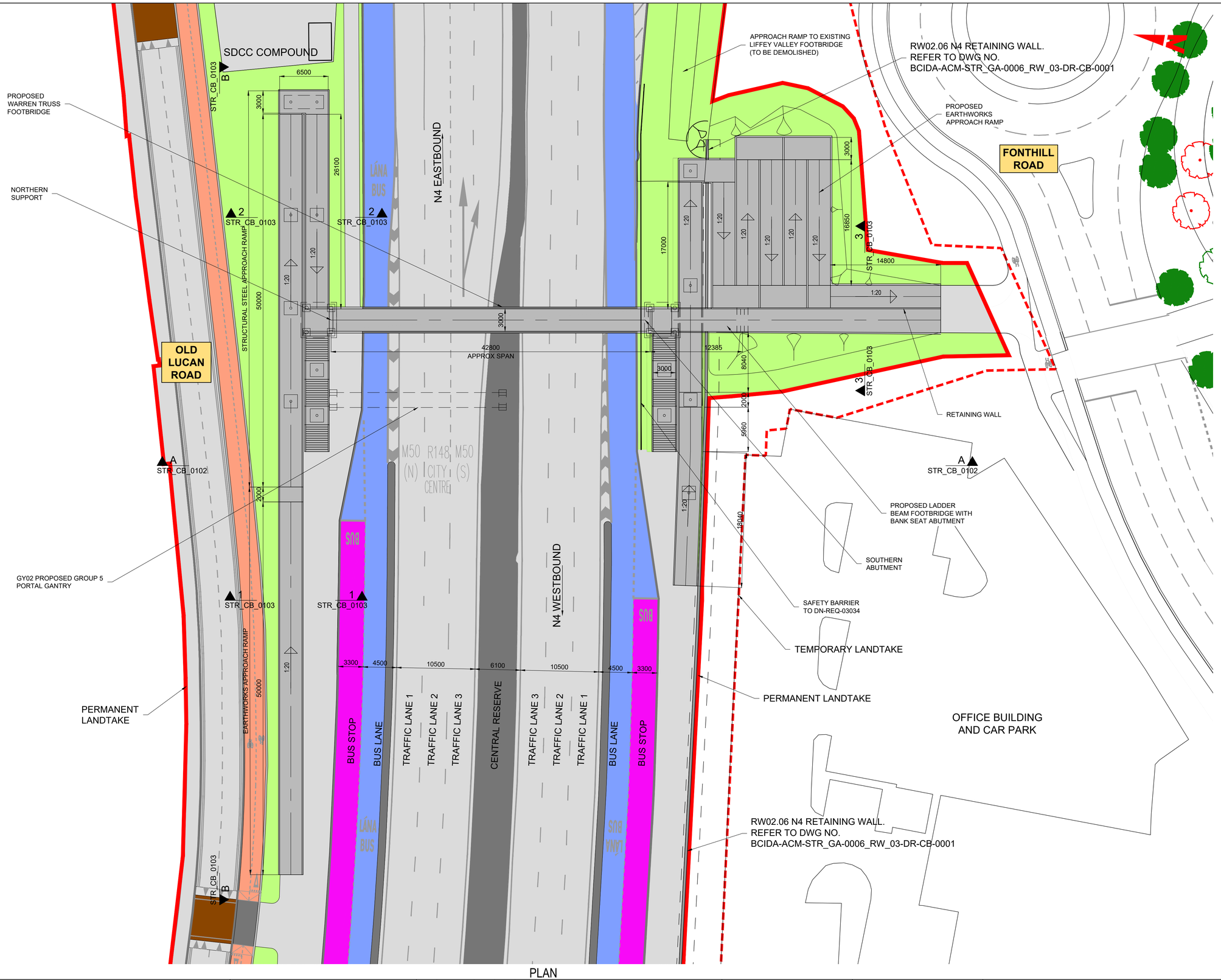


Photo 1 – Proposed bridge location looking South

Photo 2 – Proposed bridge location looking North

Photo 3 – Existing Liffey Valley Footbridge (east of proposed bridge location)

Appendix B Drawings



PLAN

Project Ireland 2040 Building Ireland's Future

Rev	Date	Drn	Chk'd	App'd	Description
L04.1	12/07/21	---	---	---	
L03	25/06/21	SH	CA	JS	ISSUED FOR APPROVAL
L02	22/04/21	DH	NR	JS	ISSUED FOR PEER REVIEW
L01	09/12/20	DH	AD	JS	STAGE B1 - PEER REVIEW

W.I.P.

Client: NTA Údarás Náisiúnta Iompair National Transport Authority

Engineering Designer: AECOM / MOTT MACDONALD

Date	Scale	Drawn	Checked	Approved
12/07/21	1:250 @ A1, 1:500 @ A3	---	---	---

Project Code	Originator Code	QMS Code
BCIDA	ACM	

Programme Title: **BUSCONNECTS DUBLIN CORE BUS CORRIDORS INFRASTRUCTURE WORKS**

Drawing Title: LUCAN TO CITY CENTRE SCHEME ST01.06 N4 PEDESTRIAN BRIDGE PLAN

Drawing File Name	Sheet Number	Status	Rev
BCIDA-ACM-STR_GA-0006_BR_03-DR-CB-0101	1 of 1		L04.1

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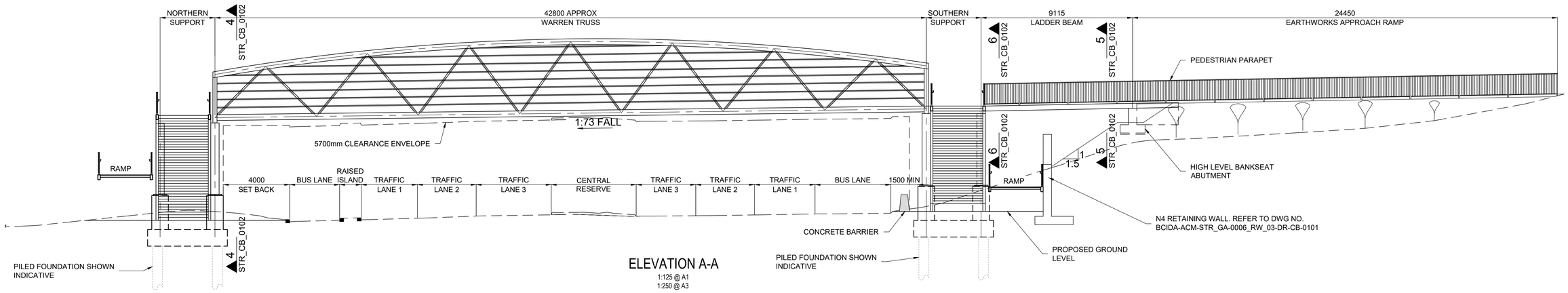

ELEVATION A-A

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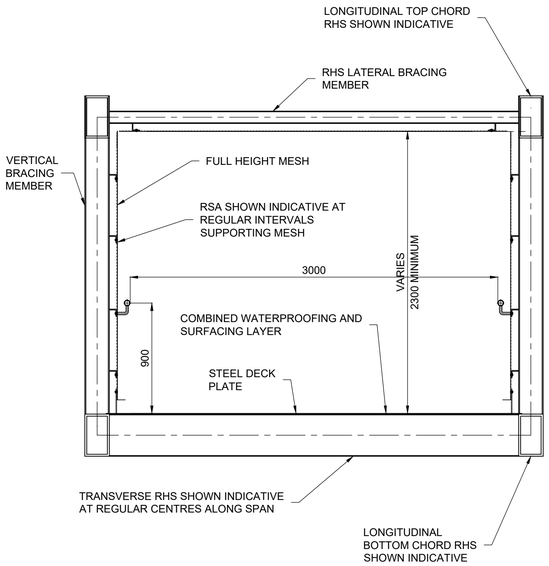
1:250 @ A3



TYPICAL SECTION THROUGH FOOTBRIDGE

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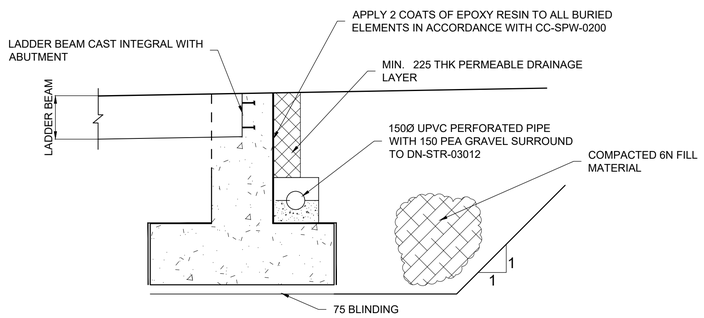
1:50 @ A3



TYPICAL SECTION THROUGH HIGH LEVEL BANK SEAT ABUTMENT SUPPORT

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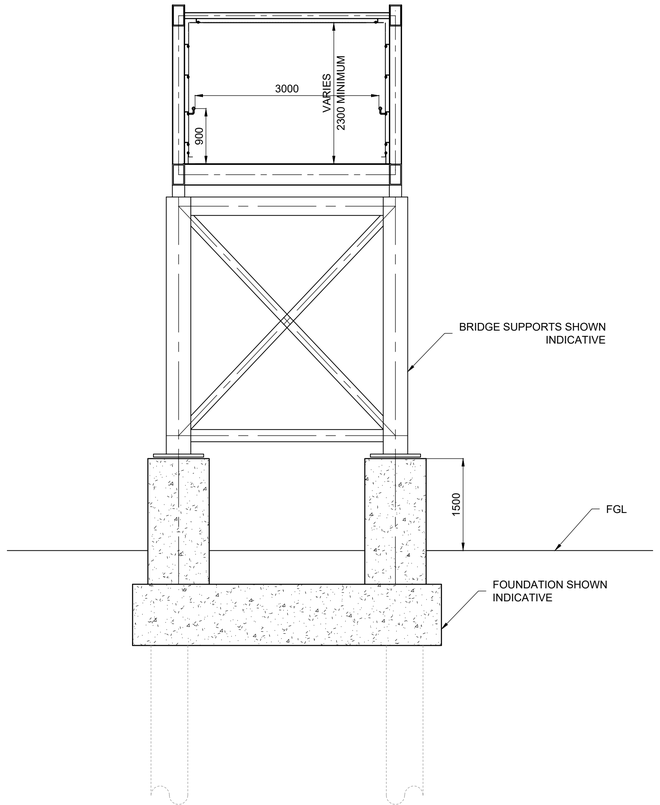
1:50 @ A3



SECTION 4-4

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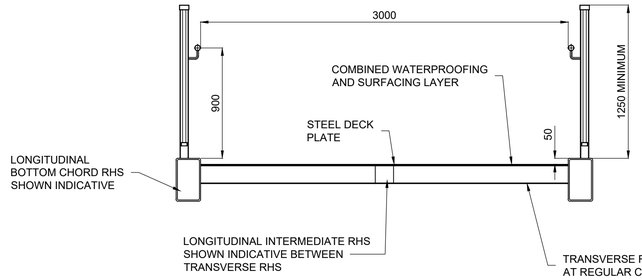
1:100 @ A3



SECTION 5-5

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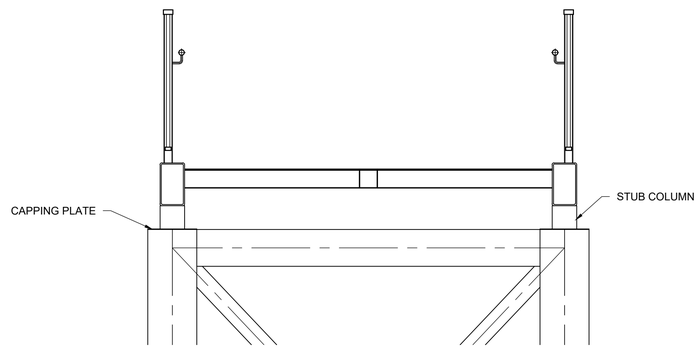

SECTION 6-6

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1:50 @ A3

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Rev	Date	Drn	Chk'd	App'd	Description
L04.1	13/07/21	---	---	---	
L03	25/06/21	SH	CA	JS	ISSUED FOR APPROVAL
L02	22/04/21	DH	NR	JS	ISSUED FOR PEER REVIEW
L01	09/12/20	DH	AD	JS	STAGE B1 - PEER REVIEW

W.I.P.

Client: NTA Údarás Náisiúnta Iompair National Transport Authority
Engineering Designer: AECOM / MOTT MACDONALD

Date	Scale	Drawn	Checked	Approved
13/07/21	AS SHOWN @ A1 AS SHOWN @ A3	---	---	---

Project Code	Originator Code	QMS Code
BCIDA	ACM	

Programme Title: BUSCONNECTS DUBLIN CORE BUS CORRIDORS INFRASTRUCTURE WORKS

Drawing Title: LUCAN TO CITY CENTRE SCHEME ST01.06 N4 PEDESTRIAN BRIDGE DETAILS SHEET 1

Drawing File Name	Sheet Number	Status	Rev
BCIDA-ACM-STR_GA-0006_BR_03-DR-CB-0102	1 of 1		L04.1

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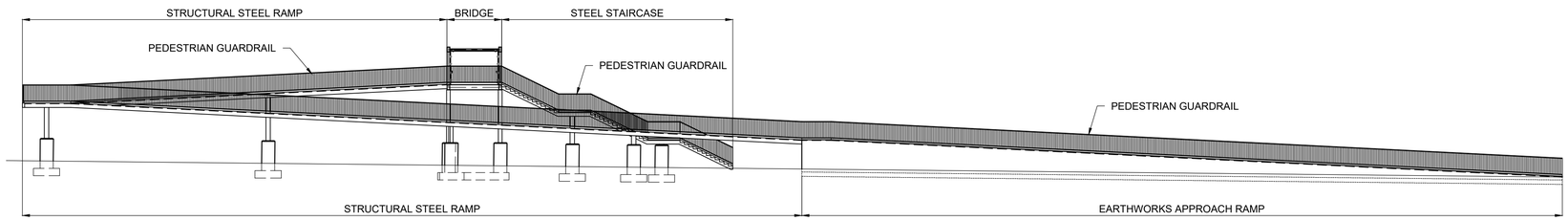

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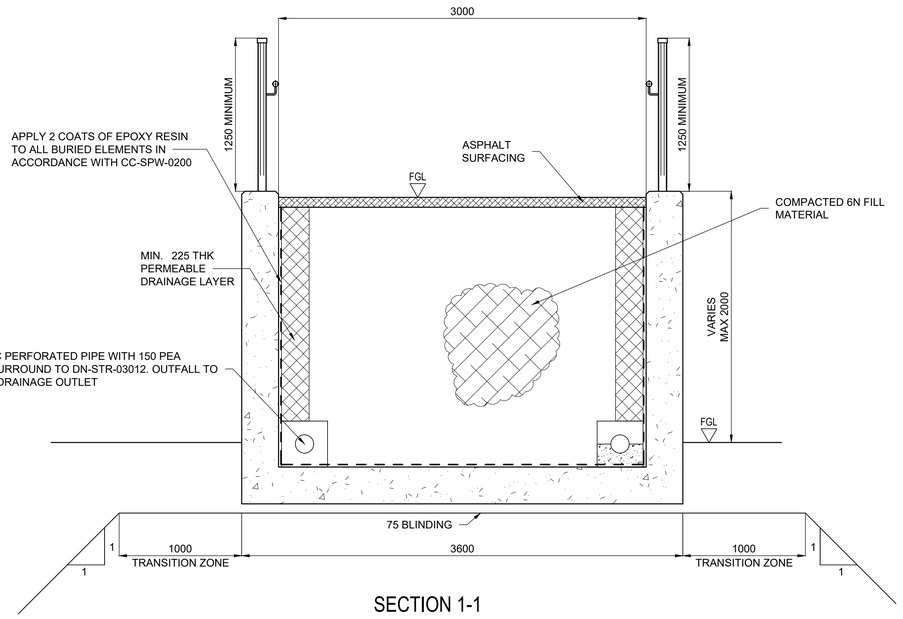

SECTION 1-1
TYPICAL SECTION THROUGH EARTHWORKS APPROACH RAMP

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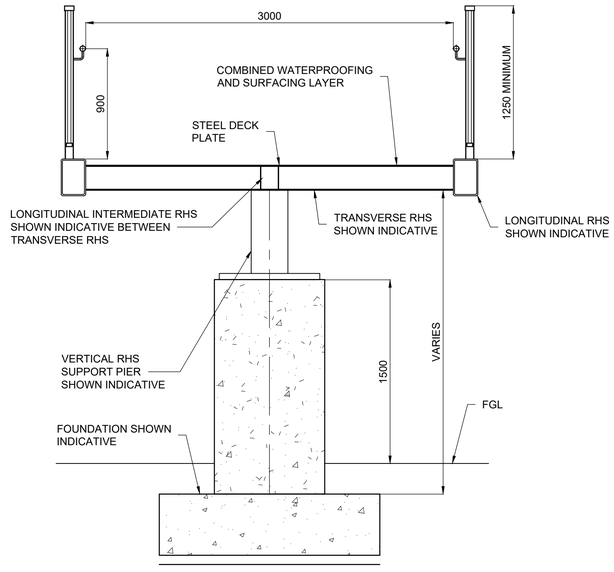

SECTION 2-2
TYPICAL SECTION THROUGH STEEL RAMP AT SUPPORT

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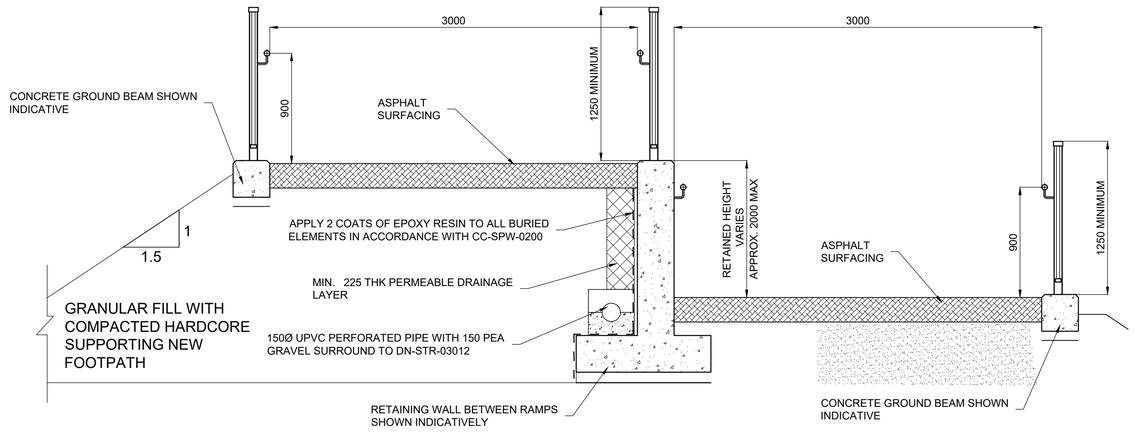

SECTION 3-3
TYPICAL SECTION THROUGH EARTHWORKS APPROACH RAMP

1:25 @ A1
1:50 @ A3

Project Ireland 2040
Building Ireland's Future

Rev	Date	Drn	Chk'd	App'd	Description
L01.1	13/07/21				

W.I.P.

Client: NTA — Údarás Náisiúnta Iompair, National Transport Authority

Engineering Designer: AECOM, MOTT MACDONALD

Date	Scale	Drawn	Checked	Approved
13/07/21	AS SHOWN@ A1 AS SHOWN@ A3			
Project Code: BCIDA	Originator Code: ACM	QMS Code:		

Programme Title: **BUSCONNECTS DUBLIN**
CORE BUS CORRIDORS INFRASTRUCTURE WORKS

Drawing Title:
LUCAN TO CITY CENTRE SCHEME
ST01.06 N4 PEDESTRIAN BRIDGE
DETAILS SHEET 2

Drawing File Name	Sheet Number	Status	Rev
BCIDA-ACM-STR_GA-0006_BR_03-DR-CB-0103	1 of 1		L01.1

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Appendix C Utility Drawings

LEGEND:

ESB HV UG / ESB HV UG / ESB HV UG	EXISTING HV ELECTRICITY (UNDERGROUND)
ESB HV OH / ESB HV OH / ESB HV OH	EXISTING HV ELECTRICITY (OVERHEAD)
ESB MV UG / ESB MV UG / ESB MV UG	EXISTING MV ELECTRICITY (UNDERGROUND)
ESB MV OH / ESB MV OH / ESB MV OH	EXISTING MV ELECTRICITY (OVERHEAD)
ESB LV UG / ESB LV UG / ESB LV UG	EXISTING LV ELECTRICITY (UNDERGROUND)
ESB LV OH / ESB LV OH / ESB LV OH	EXISTING LV ELECTRICITY (OVERHEAD)
GNI LP / GNI LP / GNI LP / GNI LP	EXISTING LP GAS NETWORK
GNI MP / GNI MP / GNI MP / GNI MP	EXISTING MP GAS NETWORK
GNI HP / GNI HP / GNI HP / GNI HP	EXISTING HP GAS NETWORK
SW / SW / SW / SW	EXISTING STORM WATER DRAINAGE
FW / FW / FW / FW	EXISTING FOUL WATER DRAINAGE

NOTE: UTILITY LOCATIONS ARE INDICATIVE ONLY AND BASED ON UTILITY PROVIDER RECORDS

CB / CB / CB / CB	EXISTING COMBINED NETWORK
WTR / WTR / WTR / WTR	EXISTING WATER NETWORK
VM / VM / VM / VM / VM	EXISTING VIRGIN MEDIA NETWORK
DDF / DDF / DDF / DDF	EXISTING ESB DUBLIN DARK FIBRE
GNI TELCO / GNI TELCO / GNI TELCO	EXISTING TELCO DUCT
ENET / ENET / ENET / ENET	EXISTING ENET NETWORK
EIR / EIR / EIR / EIR	EXISTING EIR NETWORK
FB / FB / FB / FB / FB	EXSTING FIBRE DUBLIN CITY COUNCIL NETWORK
	PROPOSED KERB LINE
	SITE BOUNDARY LINE
	TEMPORARY LAND ACQUISITION

0 5.0 10.0 20.0 30.0 40.0 50.0m

SCALE 1:500 @ A1; 1:1000 @ A3

OLD LUCAN ROAD

FONTHILL ROAD

N4

N4

PROPOSED SCHEME
Tie in to Liffey Valley Shopping Center Phase 1 Ref. No. SD19A/0320

LIFFEY VALLEY SHOPPING CENTRE

CAR PARK

Liffey Valley Shopping Centre

M50-N4 Junction 7-1

Car Park

SHEET 7

SHEET 8

SHEET 9

H 250 H 200 H 150 H 100 H 50 H 0

G 400 G 450 A 2150 G 500 H 0 G 522 A 2250 A 2200 A 2100 A 2050 A 2300 A 2250 A 2400 A 2450 I 150 I 100 I 50

Project Ireland 2040 Building Ireland's Future

Rev	Date	Drn	Chk'd	App'd	Description
L03	30/06/21	PZ	NS	JS	ISSUE FOR APPROVAL
L02	22/04/21	PZ	AD	JS	ISSUED FOR PEER REVIEW
L01	23/10/20	PZ	AD	JS	STAGE A - PEER REVIEW

W.I.P.

Client: NTA Údarás Náisiúnta Iompair National Transport Authority

Engineering Designer: AECOM / MOTT MACDONALD

Date	Scale	Drawn	Checked	Approved
30/06/21	1:500 @ A1, 1:1000 @ A3	P.ZAJAC	N.SAMACHETTY	J.SEYMOUR

Project Code	Originator Code	QMS Code
BCIDA	ACM	

Programme Title: **BUSCONNECTS DUBLIN CORE BUS CORRIDORS INFRASTRUCTURE WORKS**

Drawing Title: LUCAN TO CITY CENTRE SCHEME COMBINED EXISTING UTILITY RECORDS SHEET 08

Drawing File Name	Sheet Number	Status	Rev
BCIDA-ACM-UTL_UC-0006_XX_00-DR-CU-0008	08 of 31	S3	L03

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Appendix D Designers Risk Assessment

BusConnects Package A – CBC006 Lucan to City Centre
CBC006-ST01 N4 Pedestrian Bridge
Designers Risk Assessment

Project Number:	60599126	**Revision**						
Client:	National Transport Authority	**Rev**	01	02	03	04	05	06	07
Designer:	AECOM	**Date**	05/03/21						
Contractor:	Not applicable	**Client**	✓						
Prepared by:	Rionach Murphy	**Designer**	✓						
Checked by:	Arthur Costello	**Main Contractor**	-						
Approved by:	Niamh Rodgers	**Sub-Contractors**	-						
		Other	-						

Ref.	Feature, element, process or work activity	Constraints and significant hazards identified	Risk Rating before Intervention	Designers interventions to eliminate or reduce hazards	Significant residual hazards remaining	Residual Risk Rating	Information to be provided to enable project partners to manage hazards
1	Live National Primary Road	Site is on the N4. The road will be live during majority of construction.	High	Bridge has been designed with a main span over all lanes of the N4 avoiding works within the central reserves. All traffic lanes to be closed during lifting of bridge superstructures Traffic management to be implemented to ensure that safe working zones are provided to any works near live carriageways.	Live traffic with traffic management zones	Medium	Traffic Management will be required for bridge lifts and any construction works on or near live carriageways. All traffic management plans to be developed in accordance with Chapter 8 of the Traffic Signs Manual. Contractor is to ensure that all staff are aware of the risks of working near a live road.
2	Access and egress to the site and compound	Access and egress to site and compound from busy urban area.	High	Design of the overall CBC06 Lucan to City Centre has ensured that sufficient lands are made available within the temporary CPO area. All lands are to be accessed from Fonthill Road to avoid requirements for site entrances/exits on the main N4 carriageway.	N/A	Low	Contractor to be made aware of temporary CPO area and to ensure that construction works are carried out within this area. Contractor to ensure that access and egress to the site is from Fonthill Road.
3	Site security	Unauthorised access by members of the public to the works areas	High	Sufficient space has been provided within the Temporary CPO area to allow suitable hoarding/fencing to be erected to prevent unauthorised access to the works areas	N/A	Low	Contractor to ensure that fencing is erected and maintained throughout the construction works.

Ref.	Feature, element, process or work activity	Constraints and significant hazards identified	Risk Rating before Intervention	Designers interventions to eliminate or reduce hazards	Significant residual hazards remaining	Residual Risk Rating	Information to be provided to enable project partners to manage hazards
4	Plant movements	Insufficient ground bearing pressure for site works.	Medium	Preliminary Ground investigations have been carried out to determine if there are potential risks of low ground bearing pressures.	N/A	Low	Further Ground Investigations to be carried out as part of Detailed Design to determine any further areas of low ground bearing pressures. Appropriate hoarding to be provided at construction stage to separate works from areas of adverse ground conditions.
5	Multiple Site Activities	Numerous concurrent construction projects are expected to take place at different locations along the N4/LVSC as part of the construction of CBC006, CBC007 and the bus interchange	Medium	Phasing of the construction works has been considered to avoid works being carried out in parallel on both CBC006 and CBC007	N/A	Low	Contractor to discuss sequencing and construction programme with the client and CBC007 construction team. On-site personnel to be aware of ongoing site activities and follow any appropriate safety requirements. Barriers and hoarding to be put in place as appropriate to protect on-site personnel and segregate different site activities.
6	Underground services	Potential for unknown and/or undocumented services in the vicinity of the proposed structure.	Medium	Desk top study of available utility information carried out and all known services in the vicinity of the proposed structure have been shown on preliminary design drawings.	In correctly utility locations provided in information received from utility providers. Changes to utilities in the period before construction.	Low	Further desk top study to be carried out at Detailed Design stage to identify any additional services which have been constructed in the interim. At construction stage full CAT scan site survey to be carried out prior to commencement. Any services identified should be located by hand excavation, marked and protected or re-routed before commencement of works.
7	Excavation adjacent to an existing Structure and live carriageway	Excavations required to construct the bridge run the risk of undermining the live carriageways and approach ramps to the existing Liffey Valley Footbridge	High	The bridge location and geometry has been determined to avoid excavation works near the approach ramps to the Liffey Valley Footbridge. The bridge supports have been set back from the edge of carriageways to ensure safe working zones can be achieved with minimal traffic management required.	N/A	Low	The contractor is to be aware of the risk of undermining existing N4. As part of the detailed design the construction methodology should consider if sheet piling is required to avoid undermining. The contractor is to ensure that vibration levels from excavation are limited and that safe working limits are developed prior to works.

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8	Structural Instability	Instability of structural elements during construction	High	The preliminary design has been developed for a fully through truss construction with a braced pair of truss chords to ensure stability during construction	N/A	Medium	Where required the Contractor shall ensure that temporary works are provided on site to ensure structural stability during construction. All temporary works required are to be designed by a temporary works designer.
9	Bridge Superstructure Construction	Risks to operatives during cutting & welding of steel members	High	The preliminary design has ensured that the bridge superstructure can be fabricated off site in a controlled environment and assembled on site limiting the amount of on-site works required	Works to assemble the superstructure within the site compound	Low	Contractor is to ensure that assembly of the bridge superstructure is carried out by suitably qualified steel workers
10	Bridge Superstructure Construction	Transportation and delivery of bridge superstructure	High	The preliminary design has ensured that the bridge superstructure can be fabricated off site and assembled within the site compound. The bridge will be delivered to site in sections to avoid major logistical issues with delivery of the a fully assembled superstructure	N/A	Low	Contractor and detailed designer to liaise with the steel work fabricator to ensure that transportation and delivery of the bridge can be successfully achieved.
11	Working at Height	Risk of fall of plant, materials and people.	High	The bridge design has been developed to ensure the main bridge span can be lifted into position fully assembled avoiding the need for works from height over live carriageways of the N4. Simple connection details such as bolting have been considered as part of the preliminary design to avoid the need for welding from height. Back span/ramps and stairs have also been designed to be lifted into position fully assembled where practical.	N/A	Medium	Detailed Design and Contractor to consider construction methodology of back span, ramps and stairs to ensure minimal lifts are required. Where these elements are lifted in sections the Contractor shall ensure appropriate guard rails and netting provided to the structure to prevent falling objects. Contractor to ensure suitable fall restraint systems/harnesses to be used when working at height.

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12	Night-time Working	Reduced visibility and fatigue caused by night-time working poses the risk of slips, trips, falls and unsafe working practices being incorporated.	High	The preliminary design has assumed that main span of the bridge will be lifted during night-time works and closure of the N4. The design has been developed to ensure the lifting can be carried in a single night limiting the requirements for night-time working.		Low	The Detailed Designer and Contractor will need to consider the construction methodology and sequencing to limit night-time working. Where night works are required the Contractor must ensure that all staff are briefed on the dangers of night-time work and that site personnel are not overworked and remain vigilant.
13	Anti-Social Behaviour (as built)	Risk to the site from anti-social behaviour and vandalism	Medium	The design has ensured that full enclosure of the main warren truss span is provided to avoid the risk of anti-social behaviour and items being thrown from the bridge on the live carriageways of the N4 below.		Low	The Detailed Designer and Contractor are to ensure that full enclosure is achieved through correct detailing and construction.